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Research Article

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Diffuse scattering model for human brain wave (Alpha) propagation prediction during meditation inside a temple, through ray tracing, a hypothetical study

Priyanka Bharti[1], Madhulika Bharti[2]*, Manindra Kumar[3], Prashant Kumar[4]

[1]P. G. Department of Physics, Bhupendra Narayan Mandal University, Madhepura-852113, Bihar, India, [2]Department of Botany & Biotechnology, A. N. College, Patna-800013, Bihar, India, [3]Former Faculty Member Department of Botany & Biotechnology, College of Commerce, Patna-800020, Bihar, India, [4]P. G. Department of Zoology, Jai Prakash University, Chapra-841301, Bihar, India

ABSTRACT

Electromagnetic radio waves have been propagating for billions of years through the universe since the beginning of time. Electromagnetic radio wave propagation and the communication revolution it spawned, however are products of the twentieth century. Radio propagation in a particular environment is a complex, multipath phenomenon which involves several different mechanisms. According to a traditional, simplified approach, two major urban propagation mechanisms are identified over-roof-top (ORT) or vertical propagation (VP), where one major radial path undergoes multiple diffractions on building tops, and lateral propagation (LP) where several rays reflect/diffract all vertical building walls/edges according to the geometrical Optics (GO) rules before reaching the receiver.

KEYWORDS: Radio- propagation, geometrical optics, receiver, multi-screen diffraction, frequency, brain waves, radio-terminals, 3-D RT model, neurons, electroencephalogram, electromagnetic waves

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***Corresponding Author:**
Madhulika Bharti,
E-mail: bharti.madhu1987@gmail.com

INTRODUCTION

The electromagnetic field represents one of the four known fundamental interactions in nature. It is an indispensable part of physics and it is also the driving force of chemistry and biology. Several field prediction tools have been developed for the two categories in particular multi-screen diffraction models for VP and Two-dimensional (2-D) Ray Tracing (RT) models for the simulation of LP. Unfortunately, in the common case of Base Station (BS) located at or above rooftops, VP and LP are not clearly definable (Rizk *et al.*, 1997). In such condition, 2-D-RT, multi-screen models or even a combination of them, often do not yield very good results, especially when wide-band estimates are needed. In fact, wide-band results are strongly affected by the presence of long delay, oblique paths back-scattered by far objects such as building tops, tall buildings, hills etc. Which do not belong to the vertical nor to the lateral plane. These contributions often cannot be classified as reflections or diffractions but only as "Diffuse scattering". Due to rough surfaces, decorative masonry, pipes, cables, internal irregularities, buildings, often scalier energy in a wide range of directions apparently without following the GO rules (Esposti, 2001).

Brain waves are oscillating electrical voltages in the brain measuring just a few millions of a volt. There are five widely recognized brain waves viz. Delta (δ), Theta (θ), Alpha (α), Beta (β) and Gamma (γ). Characteristics of the five basic brain waves are listed in Table 1.

Figure 1 shows true electroencephalogram (Normal human brain wave patterns i.e. Delta, Theta, Alpha & Beta) recorded from 11:59:37 AM - 12:03:12 PM for the fraction of seconds.

The human brain's electrical charge is maintained by billions of neurons. Neurons are electrically charged (or "Polarized") by membrane transport proteins that pump ions across their membranes. Neurons are constantly exchanging ions with the extra- cellular milieu, for example to maintain resting potential and to propagate action potentials. Therefore, the

brain produces both electric and magnetic fields and acts like a radio- terminal. The strong radio signals generated by

Table 1: Characteristics of the Five Basic Brain Waves

Frequency band	Frequency	Brain states
Delta (δ)	0.5–4 Hz	Sleep
Theta (θ)	4–8 Hz	Deeply relaxed, inward focused
Alpha (α)	8–12 Hz	Very relaxed, passive attention
Beta (β)	12–35 Hz	Anxiety dominant, active, external attention, relaxed
Gamma (γ)	35-42 Hz	Concentration

spontaneous rhythms of the normal brain and can be recorded as the wave samples of different wave form is depicted in Figure 1, Electroencephalogram (EEG). The EEG signals can be captured with open source hardware such as OpenBCI and the signals can be processed by freely available EEG software such as EEGLAB (Haas, 2003).

In the present work, a full three- dimensional (3-D) RT model has been developed and tested against Alpha (α) brain (Figure 2) wave band (8- 15 Hz) measurements in a typical

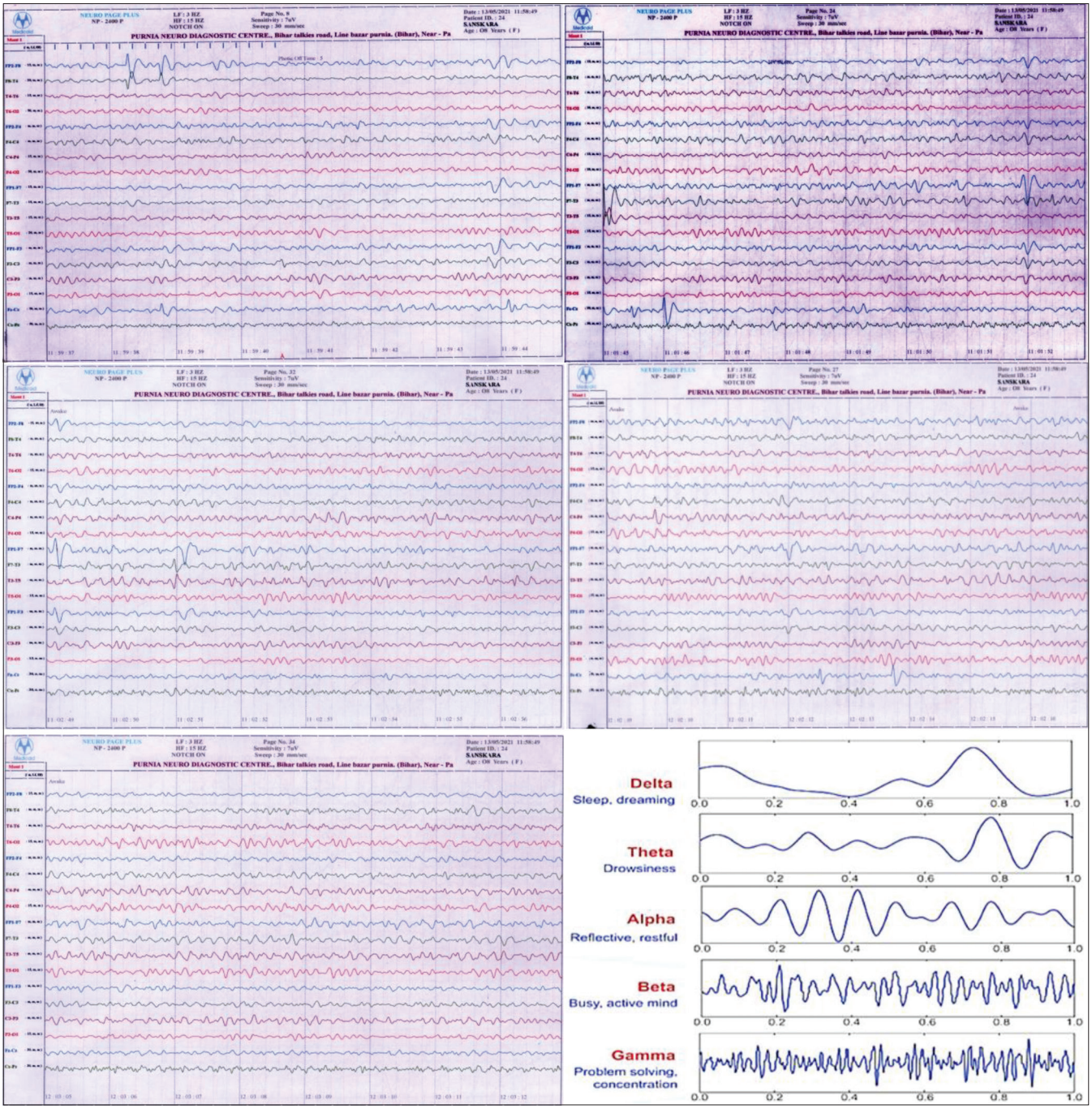

Figure 1: Showing brain wave samples for different wave form (Diagramatic)

temple environments alpha waves may be considered a bridge from the external world to internal world, and vice- versa (Ahir, 1999).

THE PREDICTION MODEL (ALPHA BRAIN WAVE)

Ray tracing is a method for calculating the path of waves or particles through a system with regions of varying propagation velocity, absorption characteristics, and reflecting surfaces (Daniele *et al.*, 1994). Under these circumstances, wave-fronts may bend, change direction, or reflect off surfaces, complicating analysis. Ray tracing solves the problem by repeatedly advancing idealized narrow beams cold rays through the medium by discrete amounts. A number of ray tracing software are available and used to generate near photo-realistic computer images. Some notable ray tracing software which are commonly used in full three dimensional (3-D) RT simulation are 3Delight, Amiga Reflections, Autodesk Softimage, LightWave3D, LuxRender, Maxwell Render, Picogen, Rayshade, Radiance, Realsoft 3D, Sunflow, TracePro, YafaRay, Zemax, etc. When a radio wave impinges on a building wall, the field is scattered in a wide range or directions. If the wall is smooth and homogeneous, under the GO asymptotic hypotheses basic inter action mechanisms (reflections, diffractions) can be singled out (Nayar *et al.*, 1991). Unfortunately, real building walls are far from being smooth, homogeneous layers, and the problem is therefore, a rather difficult one. The irregularities (windows, balconies, decorative masonry, rain- pipes, internal reinforcements, power lines, heating pipes, etc.) are usually comparable in size to the wavelength and no simple solution is available. Rigorous methods (finite elements, finite- difference time- domain, method or moments) are excessively time consuming, while asymptotic methods (GO, physical optics, UTD, etc.) have difficulty in treating compound scatterers, which is a common case (Beckmann & Spizzichino, 1963).

In this work, the new ER approach is adopted. Diffuse scattering is assumed originating from the surface of the building walls. A sort of ER is associated with each wall which takes into account not only real surface roughness but also the above mentioned surface/volume irregularities. The scattering contribution of each wall is computed directly from wall distance and orientation with respect to the Tx the Rx using simple analytic formulae which depend on only one parameter, the scattering parameter(s).

For simplicity, only first-order scattering is considered in the following. Extension to multiple scattering is straightforward.

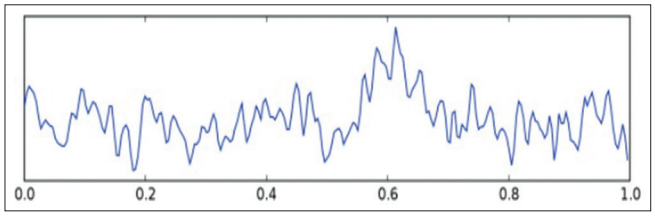

Figure 2: Showing higher Alpha activity during the meditation phase

The model is used in a different way depending on the relative position of the considered wall with respect to the radio- terminal.

DIFFUSE SCATTERING FROM "CLOSE" WALLS (INNER WALLS OF THE TEMPLE)

When a person sitting on meditation seat/podium inside a temple the walls with fresco/carvings/idol around the meditation seat are very close to the meditator and when he/she undergoes the state of meditation then the meditator (person) acts like a radio-terminal by emitting radio signals (i.e. alpha waves) and the wall is "close" to the person (radio-terminal), i.e. when the first two or three Fresnel's ellipsoids, whose focuses are Tx and the image or the Rx with respect to the wall, are fully intersected by the wall (Figure 3), the reflection contribution can be assumed equal to the specular reflection from an infinite surface and is therefore, dominant. Thus, the ER contribution is computed for "close" walls only when the direct reflected path is not present (when, for example it is obstructed).

If a ray tube of aperture dΩ impinging on the generic surface element of the wall is now considered (Figure 4a & b), part of the power is reflected in the specular ray tube, also of aperture dΩ, part (I'1) is transmitted and part (Ps) is scattered in the upper half space. Each surface element is assumed to produce a non-coherent.

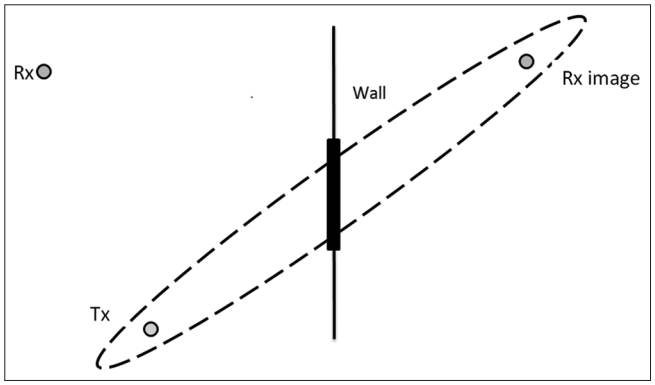

Figure 3: The state of meditation then the meditator acts like a radio-terminal by emitting radio signals

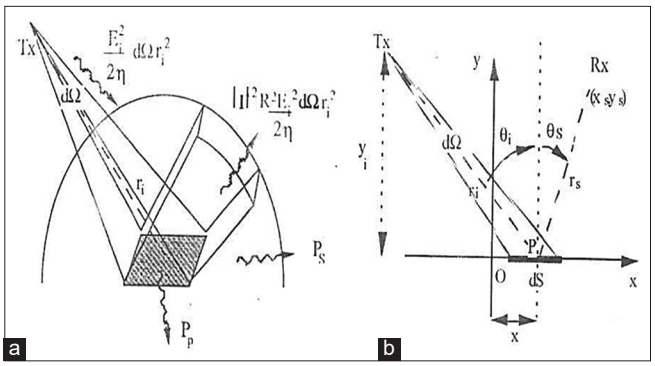

Figure 4: Generic surface element of the wall

Lambertain spherical scattered wave whose amplitude is

$$Es = Eso\sqrt{\cos(\theta s)}$$

The scattering co-efficient S is defined as the ratio between the amplitude of the scattered field and the amplitude of the incident field in the vicinity of the surface. By expressing the power flowing through the tube as the product or the power density and the cross section of the tube and performing a simple power balance, the scattered field contribution at the receiving point can be obtained.

$$dE_s^2 = K_0^2 S^2 \frac{dS\cos\theta_i \cos\theta_s}{\pi} \frac{1}{r_i^2 r_s^2} \quad K_0 = \sqrt{GOG_t P_t} \ldots *$$

Where G_t and I'_t are the gain and the input power of the Tx antenna, respectively.

The value of the total scattered field can be calculated by integrating expression …* over the wall surface. In order for the overall power balance to be satisfied, specular reflection and diffraction are consequently attenuated according to the Rayleigh factor R. Realistic, albeit probably diminutive, S and R values for typical walls have been found to be S = 0.4 and R = 0.6.

RESULT AND DISCUSSION

Meditation and Brain activity is being a very fascinating topic for the researchers doing research in the field of biophysical science. The effect of meditation on Central Nervous System (CNS), Peripheral Nervous System (PNS) and Autonomic Nervous System (ANS) became a focus of collaborative research in Neuroscience, Psychiatry and Neurobiology during the latter half of the 20th century. Research on meditation sought to be defined and characterized various practices (Kasamatsu & Hirai, 1966). The long-term practice of meditation results into alternation in brain activities i.e. state changes and trait changes respectively (Cahn & Polich, 2006). Electroencephalography has been used in many studies as a primary method for evaluating the meditating brain as well as to diagnose epileptic seizure, sleep disorders, depth of anaesthesia, coma, encephalopathy and brain death (Burns & Rajan, 2015). Apart from these, EEG used to be a first-line method of diagnosis for Tumours, Stroke and other focal brain disorders. Clinically, EEG refers to the recording of the brain's spontaneous electrical activity over a period of time, as recorded from multiple electrodes placed on the scalp. Diagnostic applications generally focus either on event-related potentials or on the spectral content of the EEG. The former investigates potential fluctuations time locked to an event, such as 'stimulus onset'. The latter analyses the type of neural oscillations i.e. the "Brain waves", can be observed in EEG signals in the frequency domain (Chiesa & Serretti, 2010). Numerous studies on human brain wave patterns and brain structures associated with creative problem solving, or some specific phases within the problem solving process (Martindale *et al.*, 1984). When an experienced meditator is under the state of meditation in a worship place, their brain emits radio waves falling under the frequency of 8- 15 Hz. Which, ultimately reflect or diffract to the walls of worship architecture (temple, church, mosque, gurudwara etc.) and forms a skirt of electromagnetic/radio-energy (Pagnoni *et al.*, 2008). In the present work it has been tried to depict a diffuse scattering model of aforesaid energy skirt of radio- waves. This type of diffuse scattering model of human brain waves (Alpha, Beta, Delta, Gama and Theta) pave a new way in the field of biophysical research which ultimately help technologists to reveal and analysed the various biomedical problems of human brain. Not only this, these studies also help to detect and analyse the negative and positive energies of the human brain and their interaction with celestial bodies of the universe (Jiang *et al.*, 2019). Therefore, diffuse scattering model of human brain wave may be variously helpful not only in the field of medical science, but also it pave a new way to reveal the mystery of parapsychology.

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